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Staging, Storage, Sizing, and Treatment Facility (SSSTF)

Stabilization Treatment Process Selection

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4. Title: Staging, Storage, Sizing, and Treatment Facility (SSSTF) Stabilization Treatment Process Selection.

5. Summary:

This Engineering Design File (EDF) presents stabilization process definition information to be used in the 30% design baseline effort design for the Staging, Storage, Sizing, and Treatment Facility (SSSTF).

The majority of the waste identified for stabilization is soil contaminated with cadmium, chromium, lead, mercury, silver and low level radionuclides. The stabilization process combines reagents with the waste via a mixing function to chemically fix the contaminants prior to disposal to the Idaho National Engineering and Environmental Laboratory (INEEL) Comprehensive Environmental Response Compensation and Liability Act (CERCLA) Disposal Facility (ICDF). Based on a consensus alternative decision evaluation, the mechanical system chosen for implementing the stabilization process is a mixing basin approach similar to commercial practice but using controlled operations within a radiological control confinement structure.

A total of 35,765 yd^3 of nonaqueous waste has been identified for stabilization. The stabilized waste output will depend on actual waste loading of the wastes in the total output volume (amount of reagents required). Stabilization of the input will result in output volume increases of approximately 39,738 yd^3 of stabilized mixture delivered to the ICDF based on a 90% waste loading, 47,687 yd^3 for a 75% waste loading and 71,530 yd^3 for a 50% waste loading. Actual waste loadings and output volumes may vary depending on waste stream contaminants and concentrations and will reflect final recipe formulation determinations determined during treatability studies.

The design base case waste loading is 75% which will result in outputs of 47,687 yd^3 to the ICDF.

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ACRONYMS

ACGIH	American Conference of Governmental Industrial Hygienists
ALARA	As Low As Reasonably Achievable
ANS	American Nuclear Society
AOC	Area of Contamination
ARAR	Applicable or Relevant and Appropriate Requirement
CAM	constant air monitor
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFS	Chemical Fixation and Stabilization
CWID	CERCLA Waste Inventory Database
D&D	decontamination and decommissioning
DOE	U.S. Department of Energy
DOE-ID	U.S. Department of Energy Idaho Operations Office
EDF	Engineering Design File
EPA	U.S. Environmental Protection Agency
HEPA	high-efficiency particulate air
HWMA	Hazardous Waste Management Act
ICDF	INEEL CERCLA Disposal Facility
IDW	investigation-derived waste
INEEL	Idaho National Engineering and Environmental Laboratory
INTEC	Idaho Nuclear Technology and Engineering Center
LDR	Land Disposal Restriction
NESHAP	National Emission Standard for Hazardous Air Pollutants
NRC	Nuclear Regulatory Commission
OSHA	Occupational Health and Safety Administration
OU	Operable Unit

PC	Portland Cement
PCB	Polycholorinated Biphenyl
PPE	Personal Protective Equipment
QA	quality assurance
QC	quality control
RCRA	Resource Conservation and Recovery Act
RD/RA	Remedial Design/Remedial Action
ROD	Record of Decision
S/S	Solidification/Stabilization
SRPA	Snake River Plain Aquifer
SSSTF	Staging, Storage, Sizing, and Treatment Facility
TCLP	Toxicity Characteristic Leaching Procedure
TFR	Technical and Functional Requirements
TRU	Transuranic
TSCA	Toxic Substance Control Act
UBC	Uniform Building Code
WAC	Waste Acceptance Criteria
WAG	Waste Area Group
WL	waste loading
yd^3	Cubic yard

Staging, Storage, Sizing, and Treatment Facility (SSSTF) Treatment Process Selection

1. INTRODUCTION

The U.S. Department of Energy Idaho Operations Office (DOE-ID) authorized a remedial design/remedial action (RD/RA) for the Idaho Nuclear Technology and Engineering Center (INTEC) in accordance with the Waste Area Group (WAG) 3, Operable Unit (OU) 3-13 Record of Decision (ROD).

The ROD requires Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) remediation wastes generated within the Idaho National Engineering and Environmental Laboratory (INEEL) boundaries to be removed and disposed of on-site in the INEEL CERCLA Disposal Facility (ICDF). The ICDF, which will be located south of INTEC and adjacent to the existing percolation ponds, will be an on-site, engineered facility, meeting DOE Order 435.1, Resource Conservation and Recovery Act (RCRA) Subtitle C, and Toxic Substances Control Act (TSCA) polychlorinated biphenyl (PCB) landfill design and construction requirements. The ICDF will include the necessary subsystems and support facilities to provide a complete waste disposal system.

The major components of the ICDF are the disposal cells, an evaporation pond, and the Staging, Storage, Sizing, and Treatment Facility (SSSTF). The disposal cells, including a buffer zone, will cover approximately 40 acres, with a disposal capacity of about 510,000 yd^3. Current projections of INEEL-wide CERCLA waste volumes total about 483,800 yd^3 DOE Order 435.1. The SSSTF will be designed to provide centralized receiving, inspection, and treatment necessary to stage, store, and treat incoming waste from various INEEL CERCLA remediation sites prior to disposal in the ICDF, or shipment off-site. All SSSTF activities shall take place within the WAG 3 area of contamination (AOC) to allow flexibility in managing the consolidation and remediation of wastes without triggering Land Disposal Restrictions (LDRs) and other RCRA requirements, in accordance with the OU 3-13 ROD. Only low-level, mixed low-level, hazardous, and limited quantities of TSCA wastes will be treated and/or disposed of at the ICDF. Most of the waste will be contaminated soil, but debris and Investigative Derived Waste (IDW) will also be included in the waste inventory. ICDF leachate, decontamination water and water from CERCLA well purging, sampling, and well development activities will also be disposed of in the ICDF evaporation pond.

Only INEEL on-site CERCLA wastes meeting the agency approved Waste Acceptance Criteria (WAC) will be accepted at the ICDF. An important objective of the WAC will be to ensure that hazardous substances disposed in the ICDF will not result in exceeding groundwater quality standards in the underlying groundwater aquifer. Acceptance criteria will include restrictions on contaminant concentrations based on groundwater modeling results with the goal of preventing potential future risk to the Snake River Plain Aquifer (SRPA).

This document presents stabilization process definition information to be used in the design of the SSSTF stabilization function.

2. SCOPE

The current scope of work includes the preparation and presentation of an Engineering Design File (EDF) for the stabilization treatment process to be used in the 30% design baseline effort for the SSSTF and the ICDF. The scope of the SSSTF includes treatment of hazardous wastes to ICDF acceptance standards (Land Disposal Restrictions [LDRs]) as identified in the *Technical and Functional*

Requirements (TFR)[1] document and project Applicable or Relevant and Appropriate Requirements (ARARs). The task deliverable effort includes the preparation and presentation of a summary EDF for stabilization treatment process definition to be used for the initial 30% design baseline effort.

Current programmatic waste inventory is contained in the CERCLA Waste Inventory Database (CWID) report.[2] Approximately 7.5% (35,765 yd^3) of total baseline inventory (483,800 yd^3) is designated as requiring stabilization. Project design basis waste description is contained in EDF *Staging Storage, Sizing, and Treatment Facility Waste Inventory Design Basis.*[3]

3. ASSUMPTIONS

Project level key assumptions and requirements are contained in *Technical and Functional Requirements, WAG 3 Staging, Storage, Sizing, and Treatment Facility* (see Reference 1). The TFR contains relevant stabilization treatment process requirements. The following assumptions reiterate or apply to this EDF in addition to TFR assumptions:

- The facility will be classified as a low hazard radiological facility with a natural phenomena performance category of PC-1 or less in accordance with DOE-STD-1020.[4]

- Radiological confinement and control will be primarily for loose surface and airborne contamination control. Confinement is used in the radiological control sense and includes the physical facility structure in combination with a working filtered ventilation system to maintain control of airflow and pressures from potentially less contaminated areas to more contaminated areas

- The stabilization treatment process facility will not be designed and operated as a transuranic (TRU) treatment facility, nor will it be designated as a TRU management facility.

- The stabilization treatment process will be designed, constructed and operated to stabilize the majority of waste identified as requiring stabilization by the most cost effective means. This stabilization of this majority of waste will be identified as normal operations. Other known and unknown waste which is determined to require stabilization will be identified as special case for the stabilization treatment process and be processed under special case treatment methodologies and controls.

- Stabilization will be performed on the required waste streams in accordance with validated recipes.

- The applicable recipes will have wide envelopes of operation.

- The recipes will need to be validated before or during stabilization campaigns:

  - A treatability study will be conducted on a surrogate sample prior to 90% design. This study will bound the treatment recipe

  - Validation entails sample batching and testing at lab scale

  - Sample batching entails size reduction, if required, mixing to recipe, and sample setup/curing

- Sample testing entails testing cured samples for (1) free liquids - no liquids as determined by visual exam and the paint filter test, (2) leach testing per Toxicity Characteristic Leach Procedure (TCLP), and (3) other criteria as identified in the landfill waste acceptance criteria.

- Stabilized waste will be required to meet LDRs.

- The Nuclear Regulatory Commission (NRC) technical position on low-level waste forms and American Nuclear Society (ANS) 16.1 criteria do not apply:

  - No immersion tests

  - No biological tests

  - No leach testing

  - Compressive strength of 500 to 600 psi as per ANS 16.1 does not apply.

- Upon validation of stabilization of waste within the envelope of operation of the recipe, campaign bulk stabilization can begin.

- Bulk stabilization of campaign wastes will entail:

  - Statistical-based sampling of bulk product in accordance with approved sampling and analysis plans. As an example, samples of sufficient size/volume will be taken to ensure compliance for process control and WAC documentation

  - Samples of sufficient size/volume will be taken to ensure adequate material for testing.

- The ICDF WAC will dictate no liquids emplacement to the landfill; this will require temporary staging and storage, then placing the waste into the landfill.

- The stabilized waste may be confined within containers after treatment for transfer to the landfill or confined within bulk transporters for transfer to the landfill. The containers will remain closed after completion of stabilization process until placement into the landfill.

- The primary radiological health and safety issue will be control of dust for loose surface and airborne contamination control, and to control external exposure. Other health and safety issues will include minimization of exposure to non-radioactive hazardous materials. The stabilization treatment process will be designed and operated to maintain individual worker radiological exposure to less than 500 mrem/year from combined internal and external radiation sources. This will require operations to be performed using a defense in depth approach. The primary defense methodology will be operationally based dust suppression methods and means. The operational driver for dust suppression will be to maintain dust levels less than a nominal 50 microgram/m^3. The defense-in-depth methodology will include stabilization treatment to be performed in a ventilated confinement with filtered ventilation air. The design method of operation will be automated equipment control with no access restrictions under normal operation. The operational driver for minimizing radiation dose (internal and external) will be adherence to as low as reasonably achievable (ALARA) principles of time, distance, and shielding as appropriate in addition to good

housekeeping procedures. Manned entry into the confinement will be allowed under radiological supervision for maintenance or special case operations. Entry may or may not require decontamination efforts and will require the use of personal protective equipment (PPE), which may include respirators or supplied air breathing suits.

- A fully functional dust suppression system and control method will reduce airborne dust levels by at least a factor of 1,000 from uncontrolled levels to controlled levels based on radiological analysis and engineering judgement (this factor will need to be validated during Title design efforts).

- Areas will be designated as radiation, contamination, high contamination, and airborne radioactivity areas and will be administered under radiological control.

- The SSSTF facility units will be closed at end of life in accordance with a DOE Order 435.1 requirements.

- Based on the baseline inventory currently available, it is assumed that F-listed constituents potentially in the soils are below LDR limits or alternative treatment standards for LDRs.

- The throughput for the stabilization facility is 11,110 yd^3/yr based on delivery scheduling as presented in EDF 1547.[5]

4. DESIGN CRITERIA

4.1 Top Tier Guidance

The project's general high-level design guidance is included in the TFR document (see Reference 1). The TFR document is the master design guidance document, which presents all design direction. Key general design guidance, as identified in the TFR or in addition to the TFR, relevant to the stabilization process include:

- The facility classification is low hazard, Performance Category PC-1.

- Facility and equipment seismic design in accordance with Uniform Building Code (UBC) Zone 2B (static).

- Project specific ARARs are provided in the TFR.

- All wastes designated for normal stabilization operations will be low level (<200 mrem/hr) contact handled wastes. Wastes with higher exposure potentials requiring stabilization will be considered special case waste and stabilization will be performed under special case stabilization treatment methodologies and controls included in the RD/RA workplan.

- Personnel worker exposure will be maintained in accordance with current INEEL radiological control documents and less than 500 mrem/year from combined internal and external radiation exposure pathways.

4.2 Environmental/Regulatory Requirements

The ARARs for compliance with environmental regulations for the SSSTF are spelled out in Table 12-3 of the OU 3-13 ROD.[6] The ARARs are tied to specific functions of the SSSTF in the Technical and Functional Requirements, WAG 3 Staging, Storage, Sizing, and Treatment Facility (see Reference 1).

4.3 Operational Safety and Health

During various operations of handling soils, the potential exists for small particles (fines) to be generated or emitted. These particles will be assumed to have radionuclides and metals attached. The U.S. Environmental Protection Agency (EPA) emission factors will be used to estimate the emission rates of the particles, radionuclides, and metals. The emission rates will be applied to the INEEL air modeling group for National Emission Standard for Hazardous Air Pollutants (NESHAPs) estimating. The emission rates will also be applied to dose rate modeling to ensure the onsite worker exposures are less than Occupational Safety and Health Administration (OSHA) and radiological limits.

The stabilization treatment process will incorporate a defense in depth approach. The primary defense methodology will be operationally based dust suppression methods and means. The defense in depth methodology will include stabilization treatment to be performed within a ventilated confinement with filtered ventilation air. Operational control management will seek to control dust levels to meet the requirements of OSHA and the American Conference of Governmental Industrial Hygienists (ACGIH). Nominal values for control of dust in the 30% design effort are:

- Less than 1 milli-gram/m^3 for total dust
- Less than 100 micro-gram/m^3 for SiO_2 dust
- Less than 50 micro-gram/m^3 for specific SiO_2 minerals within the dust.

4.4 Performance

Equipment selected will be capable of successful operations within the specified environment with a design basis of less than 20% downtime. This downtime may be operationally accommodated with the 60% efficiency ratings (6 productive hours in a 10-hour shift) at the site. Model based design tools will be utilized during the design process to estimate and quantify downtime and associated uncertainties. Downtime maintenance shall be performed via hands-on maintenance under controlled work processes and PPE. Maintenance activities will adhere to the ALARA principles.

4.5 Sampling and Analysis

The stabilization process quality objectives will be to establish a known recipe for stabilization, validate the recipe envelope in terms of the quality of the output product (waste form acceptance criteria), control the work process to maintain products within the envelope of the recipe, and document the process and product to establish an auditable paper trail. Statistically based sampling and analysis of the output product will be performed to ensure process quality control (QC). Stabilization sampling and analysis will conform to the overall project level sample and analysis plans as presented in EDF 1544.

4.6 Product Waste Form Acceptance Criteria

The acceptance criteria for the stabilized waste product include:

- Waste product passes the TCLP test (Method 1311)
- Waste product exhibits no free liquids by visual exam and passes the paint filter test (Method 9095A).

Acceptance of the stabilized waste forms according to the above criteria combined with documentation in accordance with approved quality assurance plans and sampling and analysis plans will ensure the stabilized waste meets documentation requirements for applicable treatment standards and waste disposal facility waste acceptance criteria.

4.7 Radiological Control

The key design criteria relating to operations safety and health of the stabilization process for radiological control is the need to minimize exposure and maintain exposure goals through various operational and maintenance type activities. The primary radiological health and safety issue will be control of dust for beta-gamma loose surface and airborne contamination control. Secondary health and safety issues will include minimization of exposure due to whole body penetrating radiation (gamma) and exposure to hazardous materials. The stabilization treatment process will be designed and operated to maintain individual worker radiological exposure to less than 500 mrem/year from combined internal and external radiation sources.

The stabilization treatment process will incorporate a defense in depth approach. The primary defense methodology will be operationally based dust suppression methods and means. The defense in depth methodology will include stabilization treatment to be performed within a ventilated confinement with filtered ventilation air. Confinement is used in the radiological control sense and includes the physical facility structure in combination with a working filtered ventilation system to maintain control of airflow and pressures from potentially less contaminated areas to more contaminated areas.

All wastes designated for normal stabilization operations will be low level contact handled wastes. Wastes with higher exposure potentials requiring stabilization will be considered special case waste and stabilization will be performed under special case stabilization treatment methodologies and controls included in the RD/RA work plan.

The stabilization treatment process will be designed, constructed, and operated to meet relevant TFR requirements and assumptions and current radiological control guidelines and requirements as set forth in company standards and controlling codes and orders. Equipment operational philosophy will be segregated control of process equipment with normal no access personnel restrictions in the process area. Maintenance philosophy will include hands-on maintenance with appropriate risk identification and resolution (decontamination, if required), work control, and appropriate PPE (respirators, controlled air breathing, etc.). Appendix B lists relevant radiological control requirements.

5. WASTE INVENTORY AND CHARACTERIZATION

The design basis inventory is presented in Engineering Design File #1540 (see Reference 3). This inventory EDF has been derived from the CERCLA Waste Inventory Database Report through September 2000 (see Reference 2). Contaminant identification and concentration information is derived from

available field sample data. Waste and scheduling summary information for stabilization treatment is presented in Engineering Design File #1547 – *SSSTF/ICDF Operational Scenario and Process Flows* (see Reference 5).

As presented in the design basis inventory EDF (see Reference 3) the total volume of nonaqueous waste identified for stabilization is approximately 35,765 yd^3 of waste, primarily INEEL soils. Portions of this waste have been designated as containing one or more RCRA-regulated contaminants, such as mercury, lead, chromium, cadmium, and silver as well as low levels of beta-gamma emitting radionuclide contaminants and some identified alpha-emitting radionuclide contaminants. Facility peak nonaqueous waste receipts identified for stabilization are approximately 11,110 yd^3/yr based on current delivery scheduling as presented in EDF 1547 (see Reference 5).

A very small amount of decontamination and decommissioning (D&D) waste is identified. This waste may contain PPE and will be handled as special case and solidified in accordance with an approved stabilization recipe tailored to those wastes. Other unidentified D&D wastes may be required to be stabilized based on future determinations. These would be handled on a case-by-case basis and stabilized if required using an appropriate stabilization recipe or method.

Table 5-1 summarizes soil characterization information for sites on the INEEL. This information has been compiled from geotechnical reports well drilling logs, and test hole logs (excerpts from U.S. Department of Energy Idaho Operations Office (DOE-ID) *Architectural-Engineering Manual*[7] Section 0200).

During the stabilization recipe formulation and treatability study stages of the project, additional information on soil characteristics will be obtained as necessary for recipe creation and validation. Current INEEL Geotechnical reports will be used as reference and additional information and analysis derived for INEEL soils as required.

Appendix A identifies waste information as derived in EDF 1540 (see Reference 3) for non-liquid wastes identified for stabilization and SSSTF/ICDF liquid purge water wastes identified for disposition through the SSSTF/ICDF complex.

Table 5-1. INEEL soil types.

Facility	Description of Soil Layers		Surface Layer Thickness	Depth to Basalt (ft)[a]		
	Surface Layer	Second layer	(ft)	Min	Avg	Max
Argonne National Laboratory (ANL)	Sandy silt	Silty gravel	0-1.5	5	15	38
Central Facilities Area (CFA)	Sandy silt	Sandy silt	0-2	7	19	27
Idaho National Technology and Engineering Center (INTEC)	Silty gravel	Sandy gravel	0-1	17	37	64
Naval Reactor Facilities (NRF)	Silty gravel	Sandy gravel	0-2	4	27	50
Radioactive Waste Management Complex (RWMC)	Silt	Sandy gravel	1-5	2	10	26
Test Area North (TAN)	Silt	Clay	5-10	6	39	63
Test Reactor Area (TRA)	Silty gravel	Sandy gravel	0-1	14	48	73
Waste Reduction Operations Complex (WROC)	Sandy silt	Silty gravel	0-2	6	7	8

a. Depth to basalt is from monitoring well drill logs.